

Nanocrystallization in Iron Alloys Induced by Friction Treatment and Nitrogen Diffusion

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By means of surface friction treatment in argon (FT) and friction nitriding in ammonia atmosphere (FN), a nonstructural surface layers were formed on iron alloys. The peculiarities of surface layers gradient structural state, obtained during friction process and nitrogen diffusion, were investigated by using X-Ray diffraction, microstructural analysis and transmission electron microscopy.

Microstructure morphology of friction treated surface layers both in argon and ammonia differs from that in the matrix. The structural dispersity gradient is observed along depth as the result of plastic deformation changing along samples depth. Ultrafine grains are noted only on some distance from the top surface. On the top surface and adjoining regions grain structure is not discovered by means of light optical microscopy.

It was determined that plastic deformation by friction caused grain refinement of bulk material surface layers independently of gas medium and samples composition. The distinction consists only in the scales of refinement. The refinement degree and the refinement layers depth under FT (without changes in chemical composition of surface layers) are less than under FN (simultaneous acting of friction plastic deformation and nitrogen diffusion).

Reflection electron diffraction patterns of friction treated surfaces both FT and FN present very blurry diffraction picture, demonstrating amorphousation of surface layer.

The average grain size was calculated from line broadening of BCC-Fe diffraction peaks by Scherrer method to be about 16 nm for FT; for FA – 10 nm on the top surface and 15-20 nm on 100 μm depth.

The mean grain size, determined from TEM observations of the top surface layer after FN, is approximately 5 nm for Fe-Ti alloys; after FT – 10 nm.

The severe high velocity plastic deformation during FA refines microcrystalline structure of bulk materials surface layers to the high chemical activity parts which sizes are stabilized by nitrogen atoms.